

U.S. Application No. 10/089,985 -- 7

In the Drawings:

Replace Figures 3 and 4 with the replacement drawing sheets included herewith.

REMARKS

Claims 14 – 26 remain in this application. Claims 14 – 17 are withdrawn from consideration. Claims 18 – 20, 22, and 24 – 26 have been amended. Reconsideration of this application in view of the amendments noted is respectfully requested.

In the December 30, 2004 Office Action, the disclosure was objected to because of certain informalities. Specifically, page 3, line 34 refers to “point IV-IV of figure 3,” but Fig. 3 does not contain “IV-IV.” Applicant has amended Fig. 3 to include reference “IV-IV.” Also, on page 5, line 13, “valve 12” should be --valve 13-- as seen in Fig. 2. Applicant has made this amendment. Further, on page 8, line 29, the examiner found the reference to “Fe₂” and “Fe₃” unclear. Applicant has amended “iron Fe₂” to be --Fe²⁺-- and “iron Fe₃” to be --Fe³⁺-- to show that these terms refer to the +2 and +3 oxidation states of iron. Applicant cannot replace these with just “iron” because these form two different types of electrodes, i.e., the behavior of an iron electrode varies greatly depending on its oxidation state.

Applicant further has amended the paragraph beginning on page 8, line 25 to correct a spelling error: “zink” now reads --zinc--. Further still, applicant has amended the paragraph beginning on page 1, line 33 to correct a typographical error: patent number “4,830,343” now reads --5,830,343--. Patent number 5,830,343 is the same patent that is referred to on page 2, line 7.

Further, in the drawings, applicant has amended Fig. 4 to show that the channels 31 are shown as dashed lines. Figure 4 plainly shows the face of the printed circuit 40, and the channels 31 are covered by the printed circuit. Hence, this is a correction to the figure and not the addition of new matter.

Claims 18 – 26 were rejected under Section 112, first paragraph as failing to comply with the enablement requirement. Particularly, clarification of the purpose of the common bias electrode and whether its function is redundant with the reference electrodes was requested.

The mechanical structure of an electrochemical sensor in accordance with the present invention is illustrated in Figures 3 through 7 very specifically. The sensor is a multi-electrode sensor having several electrode series in radial channels and one shared common bias electrode in the center. The radial channels extend from the center. The electrode series can be used in three ways as explained in the description: (a) in polarographical mode; (b) in galvanostatic mode; and (c) in differential mode. The polarographical and galvanostatic modes are referred to first on page 1, lines 11 – 15, then on page 5, line 24 through page 6, line 3. The differential mode is disclosed on page 6, lines 21 – 23. These modes are well known in the art. An advantage of the present invention is that all three modes can be measured with one physical sensor, giving versatile possibilities for in site measurement.

Turning specifically to the reference electrodes and the common bias electrode, the reference electrode does not present a stable voltage absolutely but only with respect to other electrodes in its series. This can be easily understood with the help of Liu (U.S. Patent No. 4,655,880) (see Fig. 1). The reference electrodes (R1 and R2) do not present an absolute reference (nor other electrodes), but instead they float according to an electrochemical state. The two series (13 and 14) can interfere with each other. In Liu, an error is limited when the sensor works in a polarographical mode, but the error would be very strong in a galvanostatic mode where all voltages of the electrodes would float greatly. If a typical differential +15V/-15V power source is used, one series might float near the negative end (-15V) while another series might float near the positive end (+15V). They would then inevitably interfere with each other. According to the present invention, this interference is prevented by a common bias electrode that is set between the series. The common bias electrode should have an absolutely stable voltage. It could, for example, be grounded (bias voltage = 0V), but a better bias voltage could possibly be found.

The common bias electrode and its benefit is disclosed in the application on page 3, lines 17 – 21, as well as page 8, lines 6 – 8, and in Figures 3 and 4. The examiner is

correct that the common bias electrode is being utilized to provide a stable reference. What is essential is that it provides an absolutely stable reference while the reference electrodes in each series provide a relative reference. Applicant submits that one skilled in the art presented with a sensor such as that disclosed in the specification and the drawings would use it in this way. Further, while in its simplest form a common bias electrode could be grounded, applicant submits that one skilled in the art would obviously connect an absolute stable voltage to the common bias electrode when viewing the application in its entirety.

With respect to the comments in paragraph 8 of the Office Action regarding claim 24, applicant has amended claim 24 to read that --the electrode series are arranged in such a way that liquid remains around the electrodes during a shutdown--. It is known from claim 18 (the base claim) that the electrodes are in a measurement cell through which liquid is communicated. Hence, liquid is communicated through the measurement cell, thereby coming in contact with the electrodes. Further, the electrode series are arranged so that the liquid may remain around the electrodes even when the sensor is shut off. Moreover, this structure is discussed on page 9, lines 1 – 13 of the specification and shown in Figures 6 and 7. In short, the electrode series may be arranged such that a water trap prevents liquid from leaving the measurement cell, therefore preventing the electrodes from becoming dry.

Based upon the foregoing, applicant submits that claims 18 – 26 are enabled by the specification, and applicant therefore requests that the Section 112, first paragraph rejection be withdrawn.

Claims 18 – 26 were rejected under Section 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Therefore, claims 18 – 20, 22, and 24 – 26 have been amended as follows to make the claims definite.

Claim 18 has been extensively amended. First, applicant has deleted “i.e.” from the preamble of the claim. Further, applicant has amended the claim so that the working electrodes, reference electrodes, counter electrodes, and pre-amplifiers introduced in the beginning of the claim are consistent with the same terms used later in the claim. The

measurement cell includes 4 – 15 electrode series. Each series includes a working electrode, a reference electrode, a current supplying counter-electrode, and a common-bias electrode. All of the electrode series share the same common-bias electrode, i.e., there is only one common-bias electrode in the measurement cell. Each series also includes a pre-amplifier for amplifying weak measurement signals. As an aside, applicant states that “pre-amplifier” as used in the claims is the same as an “amplifier,” i.e., their function is the same. This is merely an issue of terminology. Finally, applicant has amended the phrase “minimized connection distance” to read --located proximate the electrodes of the series--. The pre-amplifier of each series is located proximate the electrodes of the series, such as in the space between the radial series of electrodes (see page 9, lines 21 – 23).

Claim 19 has been amended such that “a common bias electrode” reads --said common bias electrode--. The common bias electrode in claim 19 is the same common bias electrode introduced in claim 18.

Claim 20 has been amended to utilize appropriate Markush-type language. Also, claim 20 has been amended to clarify the use of “Fe₃” and “Fe₂.” “Iron Fe₂” now reads --Fe²⁺-- and “iron Fe₃” now reads --Fe³⁺--. These terms refer to the +2 and +3 oxidation states of iron.

Claim 22 has been amended to depend from claim 19 instead of claim 21. Therefore, antecedent basis now exists in claim 22 for “the radial channels.” Further, “said channels” recited later in the claim has been amended to --said radial channels-- for consistency.

Claim 24 has been amended such that “sensor pipes” now read --electrode series-- and “sensors” now read --electrodes--. The general structure of the sensor and the electrode series of the sensor is claimed in claim 18. Further, structure of the electrode series is discussed on page 9, lines 1 – 13 of the specification.

Claim 25 has been amended to read in part that --each electrode protrudes into one of the radial channels--.

Claim 26 has been amended so that "the electrode" now reads --the common bias electrode--. Also, the phrase "is a high-speed temperature sensor" has been amended to read --includes a high-speed temperature sensor--.

Based upon the foregoing, applicant submits that claims 18 – 26 are now definite, and applicant therefore requests that the Section 112, second paragraph rejection be withdrawn.

Claims 18, 20, and 21 were rejected under Section 103(a) as being unpatentable over Glass et al. (U.S. Patent No. 5,120,421, hereinafter "Glass") in view of Liu (U.S. Patent No. 4,655,880). Applicant respectfully traverses this rejection. Glass discloses several electrode groups in the same chip. However, in Figs. 1 – 11, there are not independent series but only one series having several working electrodes, one reference electrode, and one counter electrode. Since only one series is involved, a common bias electrode is irrelevant to this arrangement. Further, in Fig. 12, several electrode groups are presented in one chip. In this arrangement, however, the counter electrodes (206) are connected together. Hence, Glass does not disclose independent series of three or even two electrodes, nor does Glass disclose a common bias electrode. Furthermore, Liu does not disclose at least three series of electrodes nor a common bias electrode.

The present invention, as claimed in claim 18, is a sensor including a measurement cell. The measurement cell includes electrodes arranged in 4 to 15 electrode series. Each electrode series includes at least a working electrode, a reference electrode, a current-supplying counter electrode, and a common-bias electrode. The common-bias electrode is shared by all of the series and is therefore the same electrode in each series. Each electrode series also includes a pre-amplifier for amplifying weak measurement signals. The purpose and function of the reference electrodes and the common-bias electrode in this electrode series arrangement is discussed in detail above and incorporated herein by reference. Neither Glass nor Liu teach or suggest such an electrode series arrangement wherein the electrode series share a common bias electrode. Furthermore, Glass and Liu are incapable of performing the functions of the present invention.

For these reasons, claim 18 is patentable over Glass and Liu, and any combination thereof. Claims 20 and 21, depending directly from claim 18, are therefore also patentable over Glass and Liu, and any combination of these references. Therefore, applicant respectfully requests that the Section 103(a) rejection of claims 18, 20, and 21 over Glass in view of Liu be withdrawn.

Claims 18, 20, and 21 were rejected under Section 103(a) as being unpatentable over Winqvist et al. (Meas. Sci. Technol., 9, pp. 1937-1946, 1998, hereinafter "Winqvist") in view of Liu. Applicant respectfully traverses this rejection. Winqvist discloses a sensor ("electronic tongue") having five independent working electrodes, one independent reference electrode, and one independent auxiliary electrode. Winqvist fails to teach or suggest a sensor having 4 to 15 electrode series, each series including a working electrode, a reference electrode, a current-supplying counter electrode, and a common-bias electrode, wherein the common-bias electrode is shared by all of the series and is therefore the same electrode in each series. Again, the purpose and function of the reference electrodes and the common-bias electrode in the present electrode series arrangement is discussed in detail above and incorporated herein by reference. Further, as discussed above and incorporated herein by reference, Liu similarly does not teach or suggest the structure of the present invention. Therefore, neither Winqvist nor Liu teach or suggest the present electrode series arrangement and hence, neither Winqvist nor Liu are capable of performing the functions of the present invention.

For these reasons, claim 18 is patentable over Winqvist and Liu, and any combination thereof. Claims 20 and 21, depending directly from claim 18, are therefore also patentable over Winqvist and Liu, and any combination of these references. Therefore, applicant respectfully requests that the Section 103(a) rejection of claims 18, 20, and 21 over Winqvist in view of Liu be withdrawn.

Claim 21 was rejected in the alternative under Section 103(a) as being unpatentable over either Glass or Winqvist in view of Liu as applied to claim 18 above, and further in view of Toxic Gas CiTiceLs (hereinafter "Citicels"). Applicant respectfully traverses this

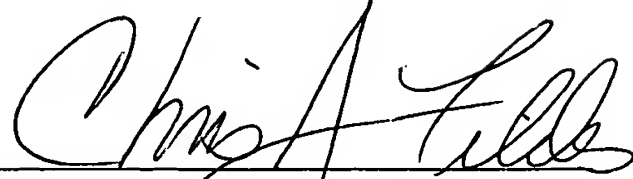
rejection. Applicant incorporates by reference the arguments made above with respect to Glass, Winqvist, and Liu. Based upon these arguments, claim 18 is patentable over Glass, Winqvist, and Liu, and any combination of these references. Claim 21, depending directly from claim 18, is therefore allowable over Glass or Winqvist in view of Liu, and any further combination of these references with Citicels. Therefore, applicant respectfully requests that the Section 103(a) rejection of claim 21 over either Glass or Winqvist in view of Liu as applied to claim 18 above, in further view of Citicels be withdrawn.

Claim 24 was rejected under Section 103(a) as being unpatentable over either Glass or Winqvist in view of Liu as applied to claim 18 above, and further in view of Goerg et al. (U.S. Patent No. 3,616,272, hereinafter "Goerg"). Applicant respectfully traverses this rejection. Applicant incorporates by reference the arguments made with respect to Glass, Winqvist, and Liu above. Based upon these arguments, claim 18 is patentable over Glass, Winqvist, and Liu, and any combination of these references. Thus claim 24, depending directly from claim 18, is allowable over any combination of Glass, Winqvist, and Liu, and any further combination of these references with Goerg. Therefore, applicant respectfully requests that the Section 103(a) rejection of claim 24 over either Glass or Winqvist in view of Liu as applied to claim 18 above, in further view of Goerg be withdrawn.

Finally, applicant submits that claims 19, 22, 23, 25, and 26, having only been rejected under Section 112, first and second paragraph, and having been amended to overcome these Section 112 rejections, are also allowable.

This amendment and request for reconsideration is felt to be fully responsive to the comments and suggestions of the examiner and to present the claims in condition for allowance. Favorable action is requested.

Respectfully submitted,
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A handwritten signature in black ink, appearing to read "Chris J. Fildes", written over a horizontal line.

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